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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 102, PART I.

B. T. GALLOWAY, *Chief of Bureau.*

SUMMARY OF RECENT INVESTIGATIONS
OF THE VALUE OF CACTI
AS STOCK FOOD.

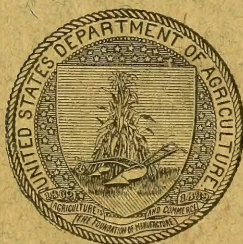
BY

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MECHANIC ARTS.

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B. T. GALLOWAY, *Chief of Bureau.*

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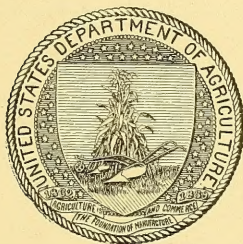
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SUMMARY OF RECENT INVESTIGATIONS OF THE VALUE OF CACTI AS STOCK FOOD.^a

INTRODUCTION.

In connection with introductions, the improvement of species, and a general study of the economic relationships of native and introduced species of cacti the authors have jointly undertaken a somewhat critical comparison of the species of this group from a forage standpoint. In order to make the chemical work worth while it has been necessary to put the characterizations of the different forms and species in such condition that they are recognizable to others. This could only be done by the use of copious notes in connection with each, for names are of uncertain meaning and in many cases will be of uncertain significance in this group of plants for a long time to come. The chemical side of the investigations seems to be essential, for when these studies were begun there was but little literature dealing with the cacti from a forage standpoint.

^aIn two publications of the United States Department of Agriculture (Bulletin No. 74 of the Bureau of Plant Industry and Bulletin No. 91 of the Bureau of Animal Industry) the value of the cacti as forage plants has been demonstrated. Since these plants are known to possess important economic value more knowledge concerning them is desirable. As a basis for future investigations, the Bureau of Plant Industry and the Agricultural Experiment Station of New Mexico have collected specimens of these plants and their fruits from a wide area, from which a large number of chemical analyses have been made. The results are detailed in the following pages, which contain 187 fodder analyses and 26 complete ash analyses. The territory from which the material was collected extends from central Texas to California and southward to the central plateau of Mexico.

Attention is called to the fact that the apparent high content of fats and protein in the fruit of certain species is due to the large amount of these classes of nutrients found in the seed. As these seeds are surrounded by a dense layer of wholly indigestible tissue, the high content of ether extract and protein is misleading. The analyses show that the fodder value of the fruit of cholla (*Opuntia fulgida*) especially is little more than that of the stems. It will be seen that in chemical composition the different forms of cactus compare favorably with ordinary green fodders and root crops.

There are many points of special interest in connection with the ash analyses, particularly the high content of potash, magnesium, and calcium. Altho the cane cacti show a relatively higher food value, practical considerations relating to growth and ease of propagation render them of less value than the prickly pear, except in certain limited localities where they are especially abundant.—W. J. SPILLMAN, *Agriculturist in Charge of Farm Management Investigations.*

The investigations have been conducted in cooperation between the Office of Farm Management Investigations of the Bureau of Plant Industry and the Agricultural Experiment Station of New Mexico for the purpose of determining, if possible, the extent of variation and the nature of the food constituents of the different species which are likely to be utilized as food for stock. The plants are grouped under three general headings—prickly pears, cane cacti, and miscellaneous—the first group being by far the most important, tho the second is largely utilized in sections where its different representatives grow. Three or four members of this group have been fed to stock with more or less success. The third group consists of miscellaneous species from other cactus genera, which on the whole are but little utilized as stock feed, altho it is clearly shown that some of the species have been fed in rare instances. The interest in this group is largely a matter of comparison with the others.

Details of the investigations are published in Bulletin No. 60 of the Agricultural Experiment Station of New Mexico.

THE SAMPLES OF CACTI ANALYZED.

Considerable importance is attached to the method of sampling, it being recognized that uniform samples of such succulent and variable plants are difficult to secure. It appeared more logical, therefore, to describe the samples in such a way as to give other investigators and the reader an accurate idea of the portion of the plant used in the chemical analysis. The sample is indicated by a formula—for example (2-1-4-3-5) 3—in which the left-hand figure indicates the number of terminal joints, the second number from the left the number of joints next to the terminal joint, and so on, the figure outside of the parentheses indicating the number of plants from which the sample was collected. All samples were forwarded to the laboratory in tin cans from which a minimum of evaporation took place. They were prepared by first being sliced open, so as to expose a maximum of cut surface, and dried by artificial heat at a temperature of not more than 70° C. The spines were then singed off by a small flame of complete combustion, care being taken neither to deposit combustion products upon nor injure the specimens. In the analyses the methods of the Association of Official Agricultural Chemists were followed, with the exception of a few modifications in the determination of certain ash constituents.

WATER CONTENT.

A collection of samples for chemical analysis was begun in 1904, and a fairly complete set was secured during that year; but, owing to the uncertainty due to the analysis of single samples, these were nearly all duplicated in 1905, in most cases from the same localities.

Fortunately there was a great difference between the rainfall during the months from January to March of 1904 and 1905. The effect upon the water content of the plants is fairly well illustrated in the different tables of analyses, altho no special effort was made to collect the samples for the purpose of showing this feature in detail. There are some apparent exceptions to the rule that the samples collected in 1904 contain more water than those collected in 1905; but this may be accounted for in some cases by the difference in the portions of plant collected or in other cases possibly by local conditions. The amount of water in the different samples analyzed varied from 60.99 to 95.5 per cent. The miscellaneous group is relatively more succulent than either of the other two, the average amount of water being 87.88 per cent, while the prickly pears averaged 84.26 per cent and the cane cacti 78.47 per cent. As a rule, the fruit contained more water than the stems and the younger growth more than the older.

The difference in the species in the field during a dry and a wet season is very marked, and even prickly pear has its limit of drought endurance. Experience in southern Texas demonstrates that it is much reduced in value during very prolonged dry seasons, for it becomes tough and leathery. "Fat pear" is largely the result of distention of the tissues by water. Some species, *Opuntia fulgida* especially, when a favorable moist season follows an exceptionally dry one, will absorb so much water that the fruits and young joints become ruptured by the excessive turgidity, and this often occurs with the fruit of nopal camueso and other cultivated Mexican species.

ASH CONTENT.

Plants grown in the arid and semiarid Southwest, where there is an abundance of soluble salts in the soil, are found to contain more ash than those grown in regions of frequent rainfall. The cacti are certainly no exceptions to this rule. The average ash in the air-dried stems and fruits of the prickly pears analyzed amounts to 18.25 per cent, for the cane cacti 15.50 per cent, and for the miscellaneous group 13.54 per cent, one sample running as high in ash as 33.8 per cent of the air-dried substance. These averages would be still higher if they did not include the ash of fruits, which always contain less ash than the stems. The average ash in the air-dried fruits of the prickly pears, for instance, is 13.21 per cent, which is 5.4 per cent less than is contained in an average of both stems and fruits of this group and 6.35 per cent less than is in the stems alone. It is the seed which is especially low in ash, the fleshy portion resembling the stem more closely so far as its ash content is concerned. This is brought out very forcibly in samples Nos. 8022*a* and 8022*b*, the former being the fleshy

portion and the latter the seed of *Opuntia phaeacantha*. The fleshy portion contained 25.60 per cent of ash, while the seed contained only 1.77 per cent.

The elements of the ash are present in about the same proportion as in the ash of other plants, except potassium, magnesium, and calcium, which are found in large amounts. It is probably the presence of these salts, coupled with the high water content, that causes cattle to scour when fed on an exclusive roughage ration of these plants.

In the following table there is given a complete analysis of the ash of a few of the samples, together with the results of the analysis of a composite sample, and an average of all the ash analyses made. Complete ash analyses were made of 26 samples besides the composite, which was a mixture prepared by carefully igniting in a muffle two grams of the ash of each of the 187 samples of cactus analyzed.

TABLE I.—*Chemical analyses of representative samples of cacti.*

Number of sample.	Scientific name of cactus.	Locality.	Date of collection.	Formula. ^a	Total ash in air-dry plant.	Carbon.	Sand.
6255	<i>Opuntia fulgida</i>	Santa Catalina Mountains, Ariz.	May 4, 1904	(6-6)	P. ct. 14.25	P. ct. .74	P. ct. 1.65
6331	<i>Echinocereus enneacanthus</i> ...	Eagle Pass, Tex.	May 10, 1904	Plant...	17.78	.26	3.31
3000	<i>Opuntia macrocentra</i>	Garfield, N. Mex.	July 11, 1904		16.45	.62	4.27
6699	<i>Cereus giganteus</i>	Tucson, Ariz.	July 28, 1904		15.75	.17	.44
7515	<i>Opuntia lindheimeri</i>	Encinal, Tex.	Jan. 17, 1905	(2-1-1)3	21.05	.14	.29
	Composite					.38	3.17
	Average of all ashes				19.65	.40	2.40

Number of sample.	Scientific name of cactus.	Pure ash.										
		Iron (Fe).	Aluminum (Al).	Manganese (Mn).	Calcium (Ca).	Magnesium (Mg).	Potassium (K).	Sodium (Na).	Silicic acid radical (SiO ₂).	Phosphoric acid radical (PO ₄).	Sulphuric acid radical (SO ₄).	Chlorin (Cl).
6255	<i>Opuntia fulgida</i> ..	P. ct. 0.21	P. ct. 0.53	P. ct. 0.09	P. ct. 24.31	P. ct. 8.10	P. ct. 11.89	P. ct. 0.00	P. ct. 0.63	P. ct. 2.54	P. ct. 2.00	P. ct. 1.33
6331	<i>Echinocereus enneacanthus</i> .	.31	.13	.09	22.66	5.07	16.61	.62	.80	1.20	2.35	2.90
3000	<i>Opuntia macrocentra</i> .	.53	.00	.56	24.75	8.25	8.33	1.57	1.56	2.14	1.16	.95
6699	<i>Cereus giganteus</i> ..	.30	.07	.15	31.64	5.78	6.66	.00	.37	.88	4.12	3.32
7515	<i>Opuntia lindheimeri</i> .	.20	.00	.49	26.71	2.27	14.22	.35	.43	1.11	1.15	2.15
	Composite..	.36	.31	.83	28.90	6.85	10.49	.47	1.90	2.70	1.94	2.20
	Average of all ashes.	.31	.24	.36	27.38	5.31	9.71	.42	1.58	1.39	1.64	1.84
												P. ct. 42.73
												P. ct. 42.63
												P. ct. 44.80
												P. ct. 41.06
												P. ct. 49.12
												P. ct. 33.76
												P. ct. 45.90
												P. ct. 90.71
												P. ct. 95.75

^a For explanation of formula, see page 6.

FOOD VALUE OF DIFFERENT PARTS OF THE PLANT.

The opinion is prevalent in southern Texas that the old woody stems of *Opuntia lindheimeri* fed there are much more valuable as a stock food than the younger growths. So firmly do many believe this that they practise cutting off and throwing away two or three of the terminal joints when feeding. In Mexico, on the contrary, the young growth is always fed; but there the species are commonly much larger and stouter, and the trunks are altogether too woody to be fed even if it were desirable to do so. The reasons for the opinions current in Texas are rather clearly brought out in the analyses. The younger growth has a relatively higher water content, and therefore probably causes more scouring, which is the only evil influence overcome by a rejection of it. On the other hand, the old stems contain a much larger proportion of fiber and are really of less forage value.

Guthrie,^a after comparing his own analysis of the stems of four Australian species with the analysis of fruits made by Wolf, concludes that the latter are of less forage value than the stems, because they contain a smaller proportion of nutritious substance and more crude fiber. Forbes,^b on the other hand, concludes from analyses of Arizona cylindrical-jointed species that the fruits of these species are relished by cattle on account of their high ether extract (including fats). Our analyses show that the ether extract is mainly a constituent of the seeds, and since these pass thru cattle undigested can contribute nothing to either the palatability or nutritive value of this part of the plant. That the seed is not digested is plainly shown in the case of *Opuntia lindheimeri* in many favorable seasons in portions of Texas. In the vicinity of Austin, in the early spring of 1904, there were numberless young plants springing up from cattle droppings in many of the pastures. They were fully as numerous in some situations as are the seedlings of the mesquite under similar conditions in favorable seasons in the river valleys of Arizona and on the plains of southern Texas.

This applies to the genus *Opuntia*, to which belong the prickly pears and cane cacti. The seeds of the other group are very different in character. There is no doubt that burros, which commonly feed upon the fruits of the viznaga (*Echinocactus wislizeni*), get a great deal of nourishment out of the seeds, which are very oily and easily masticated. It is interesting to note that No. 8170a (*Opuntia fulgida*) contains but little more food value in the whole fruit than is found in the pulpy portion alone, but in this sample most of the seeds were poorly developed or sterile. Other samples of fruit of the same species show an apparently greater food value.

^a Agricultural Gazette, New South Wales, 11: 671. 1900.

^b Arizona Agricultural Experiment Station, Annual Report, 15: 496. 1904.

TABLE II.—*Chemical composition of the different parts of fruits of cacti.*

Number of sample.	Scientific name of cactus.	Part of fruit analyzed.	Water.	Ash.	Protein.	Fat.	Nitrogen, free extract.	Fiber.	Organic matter.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8022a	<i>Opuntia phaeacantha</i>	Seed.....	7.26	1.75	6.07	11.41	23.18	50.33	90.99
8022b	<i>Opuntia phaeacantha</i>	Pulp.....	92.50	2.09	.20	.07	4.63	.51	5.41
8162a	<i>Opuntia spinosior</i> ...	Whole fruit...	77.74	2.97	1.74	1.11	11.50	4.94	19.29
8162b	<i>Opuntia spinosior</i>	Pulp.....	83.04	3.10	.55	.24	11.74	1.33	13.86
8173a	<i>Echinocactus wislizeni</i> .	Seed.....	8.59	3.09	10.92	15.46	36.59	25.37	88.31
8173b	<i>Echinocactus wislizeni</i> .	Pulp.....	94.14	.96	.63	.06	3.05	1.16	4.90
8170a	<i>Opuntia fulgida</i>	Whole fruit...	82.84	2.70	.63	.51	11.63	1.69	14.46
8170b	<i>Opuntia fulgida</i>	Pulp.....	87.17	1.58	.47	.27	9.66	.91	11.25

It must be understood that we have analyzed here but few fruits aside from those which are of more value for forage than they are as food for man. None of the cylindrical-jointed species and but few of the native prickly pears of the United States bear edible fruits.

A BALANCED RATION OF PRICKLY PEAR.

To determine in just what proportion cactus should be fed with other foods to produce a balanced ration, it is necessary to know the amount of digestible nutrients contained in the cactus, as well as those of the food or foods with which it is to be fed. This has been determined for most foods, but unfortunately there are as yet no such data for the cacti. It is hoped to be able soon to obtain the coefficient of digestion for *Opuntia lindheimeri*. For the present, all that can be done is to assume this digestibility coefficient to be the same as that of some food as similar in chemical composition and properties to the cacti as possible. It is somewhat difficult to secure a green fodder very similar in character to cactus, but perhaps its digestion coefficient will not be mist very far by assuming it to be the same as that of immature green corn fodder. By using the coefficient for this fodder the nutrients in *Opuntia lindheimeri* are found to be: Protein, 0.47 per cent; fat, 0.26 per cent; carbohydrates, 7.85 per cent. This being the case, cactus would have a nutritive ratio of 1:18, a ratio which according to the best authorities would prohibit its use alone for any feeding standard. The nutritive ratio for a standard ration varies from 1:4 to 1:12, depending upon the age, character, and kind of animal to be fed, as well as the object of the feeding; that is, whether it is desired to produce work, flesh, or milk.

If the object of feeding is to produce milk, a cow giving a heavy yield of milk should, according to the best authorities, be fed about 25 to 30 pounds a day of organic matter, containing from 1.8 to 2 pounds of digestible protein, from 0.4 to 0.7 pound of digestible fat, and 11 to 13 pounds of digestible carbohydrates, making a nutritive

ratio of from about 1:5.5 to 1:7. If a cow requiring a ration of this kind should eat cactus alone, it would take 160 pounds to furnish the fats and carbohydrates and an additional 240 pounds to furnish sufficient protein, and since to avoid scouring a cow should probably not be fed to exceed 50 or 60 pounds of cactus a day, it may be readily seen how impossible it would be for a milk cow to get even a one-sided ration from cactus alone.

A ration of 40 pounds of cactus with 10 pounds of wheat bran and 12 pounds of corn stover would furnish the nutrients in somewhat near the proper proportion. In a ration of this kind the cow would get 21.16 pounds of organic matter, containing 1.68 pounds of protein, 11.82 pounds of carbohydrates, and 0.49 pound of fat, which is in a ratio of 1:7.7.

If a ration is desired in which the cactus is fed with dried brewers' grain and cotton-seed meal, it could be made by feeding 60 pounds of cactus with 14 pounds of brewers' grain and 1 pound of cotton-seed meal. In this case 20.58 pounds of organic matter are fed, containing 2.85 pounds of protein, 10.38 pounds of carbohydrates, and 1 pound of fat. This ration would contain the nutrients in the ratio of 1:4.5. If this ration is considered too narrow, it could be widened to good advantage by feeding with it a small quantity of coarse, dry fodder, rather than by increasing the amount of cactus.

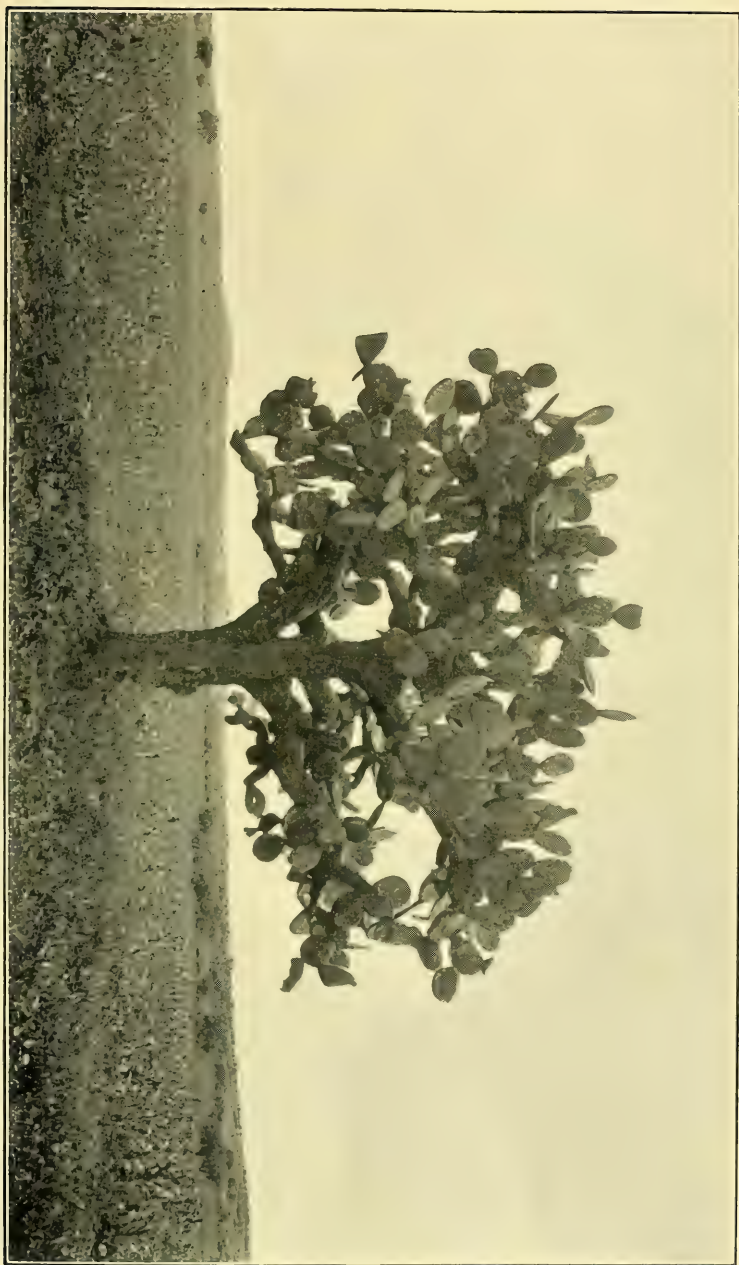
A balanced ration of cotton-seed meal and cactus can not be prepared, for if the meal be fed in just sufficient quantity to furnish the proteids it would necessitate the feeding of too much cactus to supply the remainder of the carbohydrates. From this it must not be inferred that a mixture of these foods would not make a desirable ration; in fact, current successful practise has demonstrated that it will. For example, a ration of prickly pear and cotton-seed meal was fed to steers for one hundred and five days in a recent experiment conducted by the Bureau of Plant Industry at Encinal, Tex., with a gain of $1\frac{3}{4}$ pounds of flesh a day at a cost of only $3\frac{1}{2}$ cents. Any ration of these two foods that would secure this gain each day would contain an excess of the proteids over an amount necessary for a balanced ration. Fortunately, however, an excess of proteids can be utilized in serving the function of the carbohydrates in the animal body, and this no doubt is what took place in the above experiment. Usually proteids are the most expensive foods for man and beast, and it is poor economy to substitute them for carbohydrates; yet such a condition is not uncommon in Texas cattle feeding, where cotton-seed meal is cheaper than other more starchy foods.

RELATIVE VALUE OF THE THREE GROUPS OF CACTI.

On account of several practical considerations the prickly pears are of much more value than either of the other two groups. They are more numerous in the wild state, they adapt themselves to cultivation more readily, make a more rapid growth, and are more readily propagated from cuttings, all of which are of vital importance in the economic use and handling of the crop. Practically all of the Mexican prickly pears are fed to stock to a greater or less extent, especially those growing where fodder is the most scarce, but there is only one cylindrical-jointed species (*Opuntia imbricata*) which is used to any appreciable extent. The experience of the writers has shown that *Cereus giganteus* is readily eaten by cattle when chopped up, but they know of no actual feeding having been conducted with it on any commercial scale. Mr. C. R. Orcutt states that *Echinocactus orcuttii*, which is typical of a considerable group of species, is occasionally fed in Lower California. It is only in rare instances, however, that any great quantity of feed can be secured from cacti, outside of the genus *Opuntia*, and the greater part of the feed in this genus is produced by the flat-jointed forms. There are about five species in the cylindrical-jointed group which have been fed with some success. *Opuntia imbricata*, from Mexico, has been referred to, and in various writings the use of *Opuntia arborescens*, *Opuntia spinosior*, and *Opuntia fulgida* are mentioned. To these should be added *Opuntia prolifera* from the coastal region of southern California. These species constitute, without doubt, the best of the cylindrical-jointed group, and when extent of territory covered, succulence, and ease of propagation are taken into consideration *Opuntia fulgida* and *Opuntia imbricata* are probably the most valuable of this group. *Opuntia arborescens* has a decidedly valuable characteristic in that it extends farther to the north than any of the other economic species of any of the groups, and it is fed to a considerable extent in localities from southern Colorado southward.

The use of these species, however, and, in fact, the extended use of nearly all the native species of this country and Mexico, presupposes artificial preparation. In dry seasons in southern Arizona, cattle feed upon the pendent bunches of fruits of the cholla (*Opuntia fulgida*), but it is done at a great sacrifice of comfort. The Texas pear (*Opuntia lindheimeri*) is grazed to a considerable extent by cattle, sheep, and goats without any preparation whatever, and even such thorny forms as cardon, shown in Plate I, are grazed by cattle in extreme cases.^a

^a For further discussion, see Bulletin 74 of the Bureau of Plant Industry.



NOPAL CARDON (*OPUNTIA STREPTACANTHA* LEHM.), THE MOST IMPORTANT OF THE MEXICAN PRICKLY PEARS.

COMMON AND SCIENTIFIC NAMES.

Considerable attention has been given to the popular names by which the various species are designated, especially the larger Mexican forms, but inasmuch as these are to be more fully considered in another publication now in process of preparation a full discussion of the subject is postponed.

The chaotic condition of the scientific literature and the general imperfection of knowledge of prickly-pear forms have rendered it very difficult to properly name the species discussed. The purpose of the writers has been to present the exact status of their information, indicating a doubt wherever one occurs. The Engelmann species, which are largely United States forms, are comparatively easily determined, in most cases thru a reference to the types in the herbarium of the Missouri Botanical Garden. In case of long-established species, however, it is absolutely impossible to correlate the specimens with the literature and determine what name belongs to the plant under discussion. *Opuntia tuna*, for instance, has been paraded in literature a great deal, and to it has been assigned all sorts of species; but, as pointed out by Berger and Maiden especially, no one knows what the species is, and the writers know of no way by which its identity can ever be determined.

Some species are referred to their proper genera only. Others are given common names besides, but the majority of them are given scientific names. All species receiving chemical analyses are represented in our collections by specimens mounted upon sheets in the ordinary way or put up in boxes or in liquid. Many are growing in conservatories or upon one of the plantations maintained by the United States Department of Agriculture, while the seeds of many species have been widely distributed to those interested in the scientific and economic study of the group. The work is therefore well supported by specimens to which access will be had in completing in the future such naming as has not hitherto been undertaken. It was early recognized that good dry specimens were absolutely necessary for this work in order to make the chemical analyses and determinations of permanent value.

Whenever a sample or set of samples represents a striking or constant variation it is treated separately in the text; consequently *Opuntia lindheimeri*, for instance, appears several times under two or more headings. Each number or group of numbers is accompanied by a brief set of notes made in the field beside the plant when the samples were collected, elaborated and perfected by subsequent experience. These are presented as field notes simply and not as full technical descriptions. This rather full set of notes, popular and scientific names, and, as a final resort, our specimens and photographs, will make it possible to easily verify the determinations of the writers.

CLIMATIC REQUIREMENTS OF PRICKLY PEARS.

Prickly pears and other cacti are apparently inseparably connected in the public mind with drought and heat, but this conception of the requirements for their best development is far from perfect. Our driest deserts produce none of these plants in economic quantities, and the same is true of our hottest regions. Rather than say they are adapted to conditions of extreme heat and drought, it should be said that they thrive best in a region which has an equable temperature and a considerable rainfall periodically distributed. There is certainly no region in the world where these plants grow naturally in such profusion as they do upon the plateau of Mexico, but this is not a hot country; neither is it excessively dry. It is very dry during a large part of the year. It is a desert as compared with eastern Texas, for instance, but it has a considerable rainfall during an average year. The rain falls mostly in the summer, and then the country looks like anything but a desert. The average rainfall at Zacatecas for the past ten years, as stated by Mr. Albert L. de Lautreppe, who has made a special study of the weather records of that city in connection with a business venture, is $31\frac{1}{2}$ inches, but the average for the seasons from January to April and from October to December is only five-eighths of an inch to $2\frac{1}{8}$ inches, while the average for the other months of the year is $3\frac{1}{2}$ to $7\frac{1}{8}$ inches a month. June, July, and August are the rainy months, having an average rainfall of $4\frac{1}{4}$ to $7\frac{1}{8}$ inches each for the past ten years.

While many species appear to be able to withstand high temperatures, they develop naturally in the greatest profusion where the heat is not excessive. The plateau of Mexico is a region with comparatively equable climate. Some species thrive under extremes of heat. *Opuntia lindheimeri* is at home in the lower Rio Grande Valley of Texas and Chihuahua, and the closely related *Opuntia engelmanni* and *Opuntia engelmanni cycloides* thrive in southern Arizona, where the mercury often reaches 111° F. On the other hand, there are species which grow where the winter temperatures go to at least -40° F., but the plants are small and of no economic importance in themselves except as they may be used to give a hardy character to more valuable species. The valuable species of the Mexican highlands thrive where the temperature falls to 14° F. in very rare instances. Usually the freezing point is only rarely reached here. During the past winter (1905-6) the mercury dropt at the city of Zacatecas to 14° F., and many of the more delicate spineless forms, as well as the natives, were badly injured. No pear was killed outright, but the branches were frozen down for four or more joints. These rotted and dropt off, but the old trunks survived. *Opuntia lindheimeri*, the common species of southern Texas, has been injured very severely within the memory of the present generation. It suffered some injury

during the winter of 1904-5. In the vicinity of San Antonio many of the plants droopt badly after the coldest weather, which registered a temperature of 12° F. The majority of the plants straightened up again, but in many the distal joints dropt off as the result of freezing.

THE USE OF PRICKLY PEAR IN MEXICO.

In Mexico the use of the prickly pear is much more varied than in this country. There the established plantations are guarded from animal depredations either by rude fences or hedges of some of the tall columnar species of *Cereus* or the more spiny opuntias. The latter are planted thickly in borders around the more nearly spineless forms, which stock eat readily.

All of the species are fed to stock indiscriminately. Whatever is available and can be spared is singed and fed to cattle. So far as observed, the durasnillo (*Opuntia leucotricha*) is preferred to all others. This is due to some extent to its small fiber content, but more especially to its abundant delicate spines, which are singed off more readily than those of other species which have fewer spines.

However, the extent of cattle feeding upon this kind of food is not so great in Mexico as one would suppose from the abundance of the material and the great extent of time during which the practise has been in vogue. The fact is that the average Mexican peon can not afford to feed to stock what he himself can use so profitably in other ways. The prickly pear is to him primarily an article of human food, and its place can not be taken by any other plant.

The young joints as well are eaten by man in Mexico, and the dried stems and joints are used for fuel. Of course, this fuel is exceedingly poor, but it serves the purpose in that land where this commodity is exceedingly scarce. The feeding of cacti to stock, therefore, is a secondary consideration. The limbs which break off and such other portions of the orchard material as can be spared without seriously jeopardizing the tuna crop, together with such wild forms as are available, are fed to cattle. On some of the large haciendas, especially those devoted to maguey culture, the feeding of pear to work oxen during the grassless season is a regular practise, but then only wild forms are used. Over a large part of the Republic, therefore, altho the prickly pears are much used for forage, their principal use is as an article of human food.

THE SPECIES OF CACTI AND THEIR ANALYSES.

In all, 67 species and varieties of cacti are discust, all of which have been analyzed chemically, some represented by as high as five samples. One hundred and eighty-seven fodder analyses and 26 complete ash analyses have been made. The following brief table will illustrate the characteristic composition of representative samples, together with an average of all the samples.

TABLE III.—Chemical composition of representative samples of cactus plants and fruits.

Number of sample.	Common name of cactus	Scientific name of cactus.	Character of sample analyzed.	Formula.	Green.						Air dry.									
					Spines.	Water.	Ash.	Crude protein.	Crude fat.	Nitrogen - free extract.	Crude fiber.	Organic matter.	Spines.	Water.	Ash.	Crude protein.	Crude fat.	Nitrogen - free extract.	Crude fiber.	Organic matter.
3329	Nopal prickly pear.	Opuntia lindheimeri.	Last year's growth mostly.	(5-0-0-0)4.	P. cd. 0.76	P. cd. 80.72	P. cd. 4.44	P. cd. 1.38	P. cd. 0.42	P. cd. 10.87	P. cd. 2.17	P. cd. 14.84	P. cd. 3.73	P. cd. 5.33	P. cd. 21.78	P. cd. 6.79	P. cd. 2.08	P. cd. 53.37	P. cd. 10.65	P. cd. 72.89
7571	do.	do.	Terminal joints.	(4-0-0-0)3.	Few.	88.64	1.64	.55	.29	7.72	1.16	9.72	Few.	7.03	13.40	4.49	2.40	63.15	9.53	79.57
6330	do.	do.	From old stems.	(0-0-0-1-1)3.	.58	77.95	5.81	.92	.41	11.58	3.33	16.24	2.51	5.14	25.00	3.94	1.78	49.81	14.33	69.86
7572	do.	do.	do.		Few.	84.49	2.42	.36	.27	8.80	3.65	13.08	Few.	6.35	14.60	2.19	1.65	53.18	22.03	79.05
6542	do.	do.	Early-maturing fruits.		Few.	92.19	1.09	.65	.49	2.85	2.73	6.72	Few.	4.85	13.23	7.88	5.95	34.89	33.20	81.92
5530	Nopal tapon.	Opuntia robusta.	Joints 1-3 years old.	(2-2-1)5.	.71	89.62	2.95	.63	.23	4.81	1.76	7.43	6.43	5.68	26.81	5.70	2.13	43.70	15.98	67.51
5590	do.	do.	Joints 1-5 years old.	(1-0-1-0-1)3.	.25	89.62	1.93	.46	.18	5.98	1.83	8.45	2.33	4.55	17.79	4.27	1.64	54.95	16.80	77.66
5529	do.	do.	Partly mature fruit.		Few.	88.59	1.29	1.06	1.13	3.84	4.09	10.12	Few.	5.41	10.70	8.76	9.38	31.80	33.95	83.89
5531	do.	do.	Mature fruit.		Few.	96.81	.26	.23	.23	1.80	.67	2.93	Few.	6.38	7.65	6.79	6.76	32.72	19.70	85.97
6254	Cholla.	Opuntia fulgida.	Joints 3-4 years old.	(0-0-6-1).	1.78	72.63	3.88	.95	.43	20.39	1.72	23.49	6.13	5.60	13.40	3.23	1.48	27.27	5.96	81.00
6255	do.	do.	Joints 1-2 years old.	(6-6).	2.27	78.03	3.36	1.30	.35	15.37	1.59	18.61	9.60	6.95	14.25	5.48	1.48	65.09	6.75	78.80
7802	do.	do.	Joints 4-6 years old.	(2-3-2)7.	1.72	81.51	2.21	.96	.28	14.21	8.83	16.28	8.64	7.10	11.10	4.82	1.41	71.41	4.16	81.80
7796	do.	do.	do.	(0-0-0-1-2-1)3.	.94	70.33	2.73	.95	.43	17.99	7.56	26.94	2.96	6.19	8.63	3.00	1.36	56.92	23.90	85.18
6253	do.	do.	Fruit.		Few.	83.48	2.79	.59	.36	11.18	1.60	13.73	Few.	4.88	16.05	3.39	2.09	64.36	9.23	79.07
7801	do.	do.	Fruit 1-6 years old.		Few.	80.29	3.25	.66	.47	13.77	1.66	16.46	Few.	5.43	15.60	2.70	2.24	66.05	7.98	78.97
8170a	do.	do.	Fruit, largely sterile		Few.	82.84	2.70	.63	.51	11.63	1.69	14.46	Few.	5.16	14.99	3.50	2.85	64.12	9.38	79.85
8170b	do.	do.	Fruit, largely without seed.		Few.	87.17	1.58	.47	.27	9.60	.91	11.25	Few.	4.55	11.73	3.50	1.98	71.49	6.75	83.72
5561	Sewarah.	Cercus giganteus	Mature fruit.		Few.	91.62	.98	1.05	.61	3.64	2.10	7.40	Few.	5.88	11.05	11.83	6.86	40.73	23.65	83.07
6999	do.	do.	4 sections of stem.		.92	87.31	2.20	.81	.17	8.07	1.44	10.49	6.03	8.98	15.75	5.80	37.92	10.35	75.27	
7805	do.	do.	3 sections of stem.		.28	92.36	1.30	.67	.16	4.45	1.06	6.34	3.41	5.80	15.98	8.28	1.94	54.95	13.05	78.22
	Average of all prickly pears analyzed.				.44	84.26	3.06	.73	.34	9.04	2.41	12.53	2.53	5.89	18.25	4.61	2.24	54.26	14.77	75.86
	Average of all cane cacti analyzed.				.79	78.47	3.61	1.41	.63	12.30	3.59	17.93	3.32	6.15	15.90	6.09	2.77	54.32	15.17	78.35
	Average of all miscellaneous group analyzed.				1.03	87.88	1.67	1.05	.41	7.22	1.76	10.45	8.62	6.53	13.54	4.69	2.84	54.96	13.63	79.93

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